WHAT IS CLAIMED IS:

1 A cooling apparatus for cooling a heat generator in electronic devices comprises:

a liquid cooling unit discharging heat generated by the heat generator with a coolant; and

an air cooling unit having a cooling fin group for exhausting heat discharged by the liquid cooling unit in atmosphere,

wherein the air cooling unit is stacked onto the liquid cooling unit.

2 A cooling apparatus according to claim 1, wherein the liquid cooling unit comprises:

a heat absorption surface absorbing heat by one of method of contacting and joining with the heat generator;

a flow path, in which the coolant flows, formed along the heat absorption surface; and

a liquid cooling pump for circulating the coolant within the flow path.

3 A cooling apparatus according to claim 2, wherein the flow path is formed by joining a base having a groove and the heat absorption surface.

4 A cooling apparatus according to claim 3, wherein the air cooling fin group and the base are formed in a unit.

5 A cooling apparatus according to claim 2, wherein the flow path is formed within at least one of fin among a plurality of fins composing the air cooling group.

6 A cooling apparatus according to claim 1, wherein the air cooling unit comprises an air cooling fan for flowing air to the air cooling fin group.

7 A cooling apparatus according to claim 6, wherein the air cooling unit comprises a first air channel totally covering the air cooling fin group, and an air flow generated by the air cooling fan is controlled by the first air channel.

8 A cooling apparatus according to claim 1, wherein at least one air hole for supplying air to the air cooling unit is formed in the liquid cooling unit.

9 A cooling apparatus according to claim 1, wherein the air cooling fin group is divided into a plurality of groups, and an air hole supplying air to the air cooling fin group is formed in each plurality of groups of the air cooling fin group in the liquid cooling unit.

10 A cooling apparatus according to claim 9, wherein the air cooling unit further comprises a second air channel covering each plurality of groups of the air cooling fin group, and an air flow generated by the air cooling fan is controlled by the second air channel for not to thermally interfering among the plurality of groups of the air cooling unit.

11 A cooling apparatus according to claim 10, wherein the air cooling unit further comprises an air cooling fan in each second air channel.

12 A cooling apparatus according to claim 11, wherein the air cooling unit comprises:

a first air channel totally covering the air cooling fin group;

a second air channel covering each plurality of groups of the air cooling fin group respectively;

a common air flow path formed by the first air channel; and

a plurality of individual air flow paths formed by the plurality of second flow paths.

13 A cooling apparatus according to claim 12, wherein the air cooling unit comprises an air cooling fan arranged in the common air flow path, and an air flow is generated in each individual air flow path by the air cooling fan.

14 A cooling apparatus according to claim 13, wherein a cross section area of an aperture at a border between the individual air flow path and the common air flow path is formed to become larger according the distance from the air cooling fan so that a volume of air flow in the individual air flow path becomes equal.

15 A cooling apparatus according to claim 1, wherein the air cooling unit comprises:

a piezoelectric material supported by a support member; and

an air blow plate, which is bonded to the piezoelectric material, generating air flow through vibration thereof by controlling voltage of the piezoelectric materials.

16 A cooling apparatus according to claim 15, wherein a shape of the air blow plate becomes wider with leaving from the piezoelectric material.

17 A cooling apparatus according to claim 15, wherein the air blow plate comprises:

a first part having a first elastic constant located at closer side to the piezoelectric material; and

a second part having a second elastic constant, which is higher than the first elastic constant, located at more distant side from the piezoelectric material.

18 A cooling apparatus according to claim 15, wherein the air blow plate comprises:

a first part having a first thickness located at closer side to the piezoelectric material; and

a second part having a second thickness, which is thicker than the first thickness, located at more distant side from the piezoelectric material.

19 A cooling apparatus according to claim 15, wherein the air cooling unit comprises an arrangement of a plurality of piezoelectric fans along an air flow, and the each piezoelectric fan adjacently arranged to each other is driven by shifting a vibration phase of the air blow plate of piezoelectric fan by 1/2 cycle or 1/4.

20 A cooling apparatus according to claim 2, wherein the flow path is a closed loop with a circulation method, and in a part of the closed loop, a micro channel structure having a smaller cross section area than a cross

section area of the flow path is formed.

21 A cooling apparatus according to claim 20, wherein the micro channel structure is formed by joining a base arranging a plurality of narrow grooves and the heat absorption surface.

22 A cooling apparatus according to claim 1, wherein the liquid cooling unit comprises a piezoelectric pump having a platy piezoelectric element as a driving source, and the coolant is circulated by the piezoelectric pump.

23 A cooling apparatus according to claim 22, wherein the piezoelectric pump comprises a stacked plate structure having a check valve of plate vane structure for controlling a flow direction of the coolant.

24 A cooling apparatus according to claim 22, wherein the piezoelectric pump is built into the liquid cooling unit, and the piezoelectric pump and the liquid cooling unit are integrated in a unit with metal material.

25 A cooling apparatus according to claim 22, wherein the piezoelectric pump comprises:

a plurality of pump members for introducing and exhausting the coolant; and

a plurality of piezoelectric pump driving members for driving the plurality of pump members.

26 A cooling apparatus according to claim 25, wherein the plurality of piezoelectric pump driving members control timings of introduction and exhaust of the coolant of the plurality of pump members in different timing to each other.

27 A cooling apparatus according to claim 25, wherein the piezoelectric pump driving member conducts an exhaust more than two times longer than an introduction of the pump member.

28 A cooling apparatus according to claim 1, wherein the liquid cooling

unit comprises a piezoelectric pump having a toric piezoelectric actuator as a driving source, and the coolant is circulated by the piezoelectric pump.

29 A cooling apparatus according to claim 1, wherein the liquid cooling unit comprises an evaporation-method pump circulating the coolant with evaporation of the coolant by a heat generator.

30 A cooling apparatus according to claim 29, wherein the evaporation-method pump comprises a plurality of heat generators, and a flow direction of the coolant is determined by controlling heat generation timing of the plurality of heat generators.

31 A cooling apparatus according to claim 1, wherein the apparatus further comprises:

an air cooling fan supplying air to a liquid cooling pump for circulating the coolant and to the air cooling fin group; and

an electric control circuit driving the liquid cooling pump and the air cooling fan,

wherein, an input to the electric control circuit is DC current.

32 A cooling apparatus according to claim 31, wherein the electric control circuit inputs information about a temperature of the heat generator, and the liquid cooling pump and the air cooling fan are driven so as to maintain at maximum temperature within an upper limit of the heat generator.

33 An electronic device mounting a cooling apparatus according to any one of claims 1 to 32